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Claims

[c1] A process for producing hydrogen, comprising:

catalytically reforming a first hydrocarbon portion with steam and air in an autothermal reactor to produce a first syngas effluent at a temperature from 650°to 1050°C;

supplying the first syngas effluent to a reforming exchanger;

passing a second hydrocarbon portion with steam through a catalyst zone in the reforming exchanger to form a second syngas effluent;

discharging the second syngas effluent from the catalyst zone adjacent the inlet to form a syngas admixture with the first syngas effluent;

passing the admixture across the catalyst zone in indirect heat exchange therewith to cool the admixture and heat the catalyst zone;

collecting the cooled admixture from an outlet of the reforming exchanger;

shift converting the admixture to obtain a carbon dioxide-rich gas stream lean in carbon monoxide; and

separating the carbon dioxide-rich gas stream to

form a hydrogen-lean, mixed gas stream comprising nitrogen and carbon dioxide and a hydrogen-rich product stream.

[c2] The process of claim 1, wherein the mixed gas separation comprises membrane separation.

[c3] The process of claim 1, wherein the mixed gas separation comprises pressure swing adsorption.

[c4] The process of claim 1, wherein the catalyst zone comprises catalyst tubes, the process further comprising:

supplying the first syngas effluent to a shell-side of the reformer;

supplying the second hydrocarbon portion with steam through the catalyst tubes;

discharging the second syngas effluent from the catalyst tubes adjacent the shell-side inlet to form the syngas admixture.

[c5] The process of claim 1 wherein the autothermal reformer is operated with excess air.

[c6] The process of claim 1 wherein the carbon dioxide-rich gas stream from the shift conversion comprises a molar ratio of hydrogen to nitrogen less than 3.

[c7] The process of claim 1 wherein the mixed gas separation

is free of cryogenic separation.

[c8] The process of claim 1 wherein the process is free of air separation.

[c9] The process of claim 1 wherein a proportion of the first hydrocarbon portion relative to a total of the first and second hydrocarbon portions is from 55 to 85 percent.

[c10] The process of claim 1 wherein a proportion of the first hydrocarbon portion relative to a total of the first and second hydrocarbon portions is from 60 to 80 percent.

[c11] The process of claim 1 wherein the hydrogen product stream has a purity of at least 70 volume percent.

[c12] The process of claim 11, wherein the hydrogen product stream has a purity of from 90 to 99.5 volume percent.

[c13] The process of claim 1, wherein the hydrogen product stream has a purity of at least 95 volume percent.

[c14] The process of claim 1, wherein the hydrogen product stream has a purity of at least 97 volume percent.

[c15] The process of claim 1, wherein the hydrogen product stream has a purity of at least 98.5 volume percent.

[c16] A process for generating an electrical current comprising the process of claim 1 and supplying the hydrogen-rich

product stream to a fuel cell.

[c17] A hydrotreating process comprising the process of claim 1 and supplying the hydrogen-rich product stream to a hydrotreater.

[c18] Apparatus for preparing syngas, comprising:

autothermal reactor means for catalytically reforming a first hydrocarbon portion with steam and air to produce a first syngas effluent at a temperature from 650°to 1050°C;

means for supplying the first syngas effluent to an inlet of a reforming exchanger;

means for passing a second hydrocarbon portion with steam through a catalyst zone in the reforming exchanger to form a second syngas effluent;

means for discharging the second syngas effluent from the catalyst zone adjacent the inlet to form a syngas admixture with the first syngas effluent;

means for passing the admixture across the catalyst zone in indirect heat exchange therewith to cool the admixture and heat the catalyst zone;

means for collecting the cooled admixture from an outlet from the reforming exchanger;

means for shift converting the admixture to obtain a carbon dioxide-rich gas stream lean in carbon monoxide; and

means for separating the carbon-dioxide-rich gas stream to form a hydrogen-lean, mixed gas stream comprising nitrogen and carbon dioxide and a hydrogen-rich product stream.

[c19] The apparatus of claim 18, wherein the separation means comprise a pressure swing adsorption unit.

[c20] The apparatus of claim 18, wherein the separation means comprise a membrane separator.

[c21] The process of claim 1, wherein the reforming, shift conversion and mixed gas separation comprise a process pressure from 10 to 200 bars.

[c22] The process of claim 21, wherein the reforming, shift conversion and mixed gas separation comprise a process pressure of at least 30 bars.

[c23] The process of claim 1, further comprising compressing air to the catalytic reforming with a gas turbine drive and recovering heat from exhaust from the gas turbine.